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SINGLE STATION RANGE FINDER WITH VARIABLE BASE

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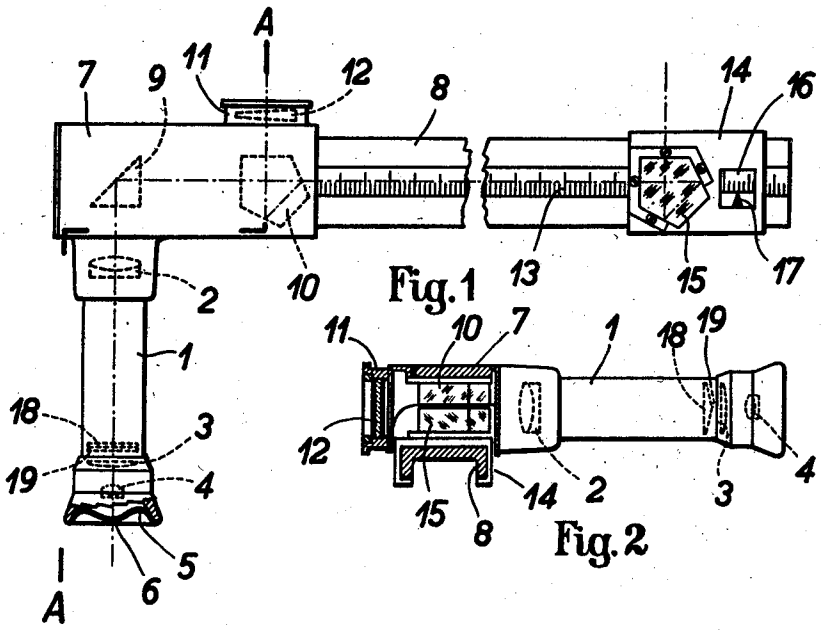


Fig.1

Fig.2

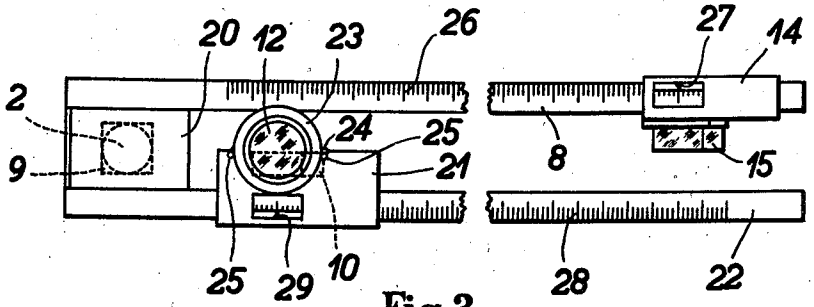


Fig.3

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SINGLE STATION RANGE FINDER WITH VARIABLE BASE

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Measurements effected by means of single station rangefinders with variable base are subject to the well-known equation resulting from the so-called measuring triangle:

$$e=\frac{b}{\delta} \tag{1}$$

wherein e is the range to be measured, b the base, and δ the parallactic angle at the target. The device which is used in said rangefinders for changing the base b is generally provided with means indicating direct the ranges e corresponding to different bases b. The actual distance of an object coincides with the indicated one, however, only when deviations δ' falsifying the parallactic angle δ do not arise in the rangefinder itself, or when these errors δ, which are hereinafter termed adjustment errors, have been compensated in any suitable manner. In rangefinders producing a variable parallactic angle at the target, these adjustment errors are eliminated, as is well known, by means of a double measurement effected through the agency of two different bases of definite lengths.

The invention makes use of a method of compensating the adjustment errors in single station rangefinders with variable base, this method consisting in the range measurement being effected with a definite parallactic angle at the target and repeated with another parallactic angle, the actual range being proportional to the difference in the base lengths in the two measurements. Accordingly, two measurements are effected subsequently to each other, the first with a definite parallactic angle δ depending on the construction of the apparatus, and the second with a definite parallactic angle $k.\delta$, in which k can have, on principle, any magnitude differing from $+1$.

The invention is based on the following consideration: If v be the telescopic magnification of a rangefinder having a variable base b, the parallax Δ seen in the field of view of this rangefinder is in the case of a target at a distance e

$$\Delta=v\left[\frac{b}{e}-(\delta+\delta')\right] \tag{2}$$

In rangefinding, the base b is known to be varied until the parallax Δ has assumed the magnitude 0. Accordingly,

$$\frac{b}{e}-(\delta+\delta')=0 \tag{3}$$

Apart from the practically unavailable case in which the base b as well as the parallactic angle δ and the adjustment error δ' assume the magnitudes 0 at one and the same time, the Equation 3 is arrived at when

$$\frac{b}{e}=\delta+\delta' \tag{4}$$

This equation corresponds to the Equation 1 when an adjustment error has been taken into consideration. Evaluating the measurement by means of Equation 4 will yield an incorrect range when the division pointed at by the indicating device represents, as usual, ranges based on Equation 1.

Substituting an angle $k.\delta$ for the parallactic angle δ entails a compensation of the parallax Δ as soon as the base b is changed to b^0, which depends on the equation

$$\frac{b^0}{e}=k.\delta+\delta' \tag{5}$$

The elimination of the angle δ' in the Equations 4 and 5 provides for the range e an Equation 6, which is without the adjustment error δ':

$$e=\frac{b-b^0}{\delta(1-k)} \tag{6}$$

When accordingly, a target at a range e is measured once with the parallactic angle δ and once with the parallactic angle $k.\delta$, the actual range e is proportional to the difference of the two determined bases b and b^0 and not influenced by any adjustment error δ', which can be assumed to be the same in both the said measurements.

Effecting this double measurement depends on the possibility of varying the definite parallactic angle δ to $k.\delta$. This change can be effected, for instance, by means of an additional refracting prism producing in one of the ray paths a deviation $\delta\ (1-k)$ or by substituting a prism of the deviation $k.\delta$ for the prism of the deviation δ. Especially simple proceedings are arrived at by using the factor $k=-1$ or $k=0$. In the case of the factor $k=-1$, which can be realized by rotating in one of the ray paths a prism of the deflection δ about the optical axis through 180°, the numerical values of the parallactic angles at the target are the same in both measurements. In the case of the factor $k=0$, the parallactic angle is zero in the second measurement, this angle being realized by removing a prism of the deflection δ from one of the ray paths or causing this prism to influence in the second measurement both ray paths.

For carrying the first said method into prac-

tice, a single station rangefinder with a variable base and a definite parallactic angle at the target is suitably provided with an optical deviating system which can be made to assume two such positions in one of the imaging ray paths as to produce two inversely equal deviations of the imaging ray pencils in the measuring plane. It is advisable in the case of the said other method to provide that the optical deviating system which is so disposed in one of the two imaging ray paths as to deflect the imaging ray pencil in the measuring plane has dimensions permitting it to influence at the same time both the said pencils when the base of the rangefinder assumes approximately the magnitude zero. This can be arrived at in a simple manner in a rangefinder having a monocular telescope and whose ray entrance apertures correspond to the upper and the lower half of the telescope objective, when each of the two systems deviating at 90° (for instance pentagon prisms), which are, as a rule, always in the ends of the base, is only half as high as the telescope objective, and when both systems are placed in the second measurement above each other on the eye-piece side of the system of the deviation δ lying in one of the ray paths and being, in its turn, so dimensioned as to correspond to the entire height of the telescope objective. An instrument thus constructed acts in the second measurement as a rangefinder which has a variable base and whose definite parallactic angle at the target corresponds to the adjustment error δ'. As this error is always comparatively insignificant, the second measurement requires such a change of the base b from $b=0$ as is so slight that the rays entering the deviating systems in the base ends are deviated substantially at an angle δ when traversing the unchanged system.

In a telescope in which the imaging rays can enter only through the one half of the objective, the produced image is known to cover nevertheless the entire image field. In a rangefinder of the construction described last, the two imaging ray pencils would, accordingly, produce overlapping images which, per se, would allow the measurement of ranges by variation of the base b until these overlapping images cover each other completely. Exact adjustments being, however, very difficult in this case, it is preferable not to use overlapping images. Moreover, each of the two imaging ray paths requires an exit pupil of its own, which may give rise to measuring errors. The telescopic system of the rangefinder is suitably provided with a bi-prism the ridge of which is parallel to the measuring plane and lies in the image plane of the telescope, and whose base surface is parallel to the imaging plane and which has such angles of refraction that the exit pupils of the upper and the lower half of the objective overlap each other in part, the plane of these exit pupils containing a diaphragm whose diaphragm aperture corresponds to those parts of the exit pupils which these pupils have in common, and the remaining part of said pupils being rendered ineffective by the diaphragm. It is thus attained that there are visible in the field of view of the telescope two partial images of the target, which are separated by a sharp line, viz. the ridge of the bi-prism, and whose coincidence is effected in the measurement.

In the accompanying drawing, which illustrates two constructional examples of the invention, Figure 1 shows the one example in plan view, Figure 2 is a section through line A—A in Figure 1, and Figure 3 represents the other example in a view offered to the eye when looking at the apparatus from the target. Both examples concern monocular rangefinders with variable base.

The rangefinder according to the first example (Figures 1 and 2) has a monocular telescope 1, whose optical parts are an objective 2, a collective lens 3 and an eye-lens 4. In the eye-piece 3, 4 of the telescope 1, a diaphragm 5 is disposed in such a manner that the diaphragm aperture 6 lies approximately in the plane of the exit pupil. A prism housing 7 and a guiding rule 8 are rigidly connected to the telescope 1. The housing 7 contains a triangle prism 9 which is so disposed in the ray path and of such height as to cover the objective 2 entirely, and a pentagon prism 10, which is only half as high as the prism 9 and coordinated to the upper half of the objective 2. A cuneiform prism 12 in a mount 11 on the prism housing 7 is disposed near the object side of the pentagon prism 10 in such a manner that its edge of refraction intersects the principal plane of the prism 10 at right angles. The height of the cuneiform prism 12 corresponds to the vertical diameter of the objective 2. The guiding rule 8, which is disposed on the lower part of the prism housing 7 and projects to the right of the observer at the telescope 1, is parallel to the measuring plane determined by the principal planes of the prisms 9 and 10 and provided with a scale 13 representing ranges. A slide 14 displaceable on the rule 8 is provided with a window 16 having an index 17 and carries a pentagon prism 15 corresponding to the pentagon prism 10. In the telescope 1, a biprism 18 is so disposed that its ridge 19 lies in, and its base surface is parallel to, the image plane of the telescope 1. The ridge 19 is parallel to the measuring plane.

The zero line of the scale 13 coincides with the index 17 when the slide 14 assumes that position on the rule 8 in which the contours of the pentagon prisms 10 and 15 cover each other. The space between the division lines of the scale 13 are determined according to the Equation 6, the magnitude k being assumed to be zero. As each of the prisms 10 and 9 deviates the entering imaging pencils at 90°, the deviation of the rays by the cuneiform prism 12 corresponds to the predetermined parallactic angle at the target. To the upper and the lower half of the objective, to which the imaging rays are directed by the prisms 10 and 15, respectively, are coordinated two exit pupils that are so displaced relatively to each other by the deviation to which the imaging rays are exposed by the biprism 18 that they overlap each other in part. The diaphragm 5 keeps the non-overlapping parts of these exit pupils out of the sight of the observer at the eye-piece, and there appears in the field of view a sharp horizontal line, viz. the ridge 19 of the prism 18, which separates the images produced by the two halves of the objective.

When in use, the apparatus is so directed to the target whose distance is to be measured that the observer looking into the eye-lens 4 sees two images of the target lying above each other. By displacing the slide 14 on the rule 8 to the right, these images are made to coincide, and the range magnitude corresponding to this coincidence and indicated by the index 17 is read on the scale 13. The slide 14 is then displaced to the left until the prism 15 lies below the prism 10 and in the rear of the prism 12, whereupon the prism 12 de-

viates the imaging ray pencils entering the prisms 10 and 15. The images produced in the telescope 1 would coincide when the index 17 is in coincidence with the zero line of the scale 13 if the apparatus were devoid of adjustment errors. Exact coincidence is obtained, however, by another displacement of the slide 14, this other displacement being comparatively insignificant in most cases. Also the range magnitudes corresponding to this other measurement is to be read on the scale 13. The actual range of the target corresponds to the difference of the said two magnitudes indicated on the scale 13. If, for instance, the first reading is 169 metres and the second −3 metres, the real range, i. e., the magnitude of the range without adjustment errors, is 172 metres.

The second constructional example (Figure 3) differs from the first example in that its prisms 9 and 10 are disposed in separate housings 20 and 21, respectively. The housing 21 is a slide displaceable on another rule 22 fast with the housing 20. The cuneiform prism 12 is in a rotatable mount 23 whose rotation is restricted to 180° by a pin 24 fast with this mount and two stops 25 fast with the housing 21 In the two extreme positions of the mount 23, the refraction edge of the prism 12 is at right angles to the measuring plane. The rule 8 has a scale 26 on which an index 27 on the slide 14 indicates ranges. The rule 22 has a scale 28 indicating ranges which corresponds to the scale 26, the zero lines of these two scales being in coincidence. To the scale 28 belongs an index 29 on the prism housing 21. The two constructional examples are the same in all other respects.

The range of a target is determined without any adjustment errors by means of two measurements also with the apparatus according to the second example. When the pin 24 touches one of the stops 25 and the index 29 is adjusted to the zero line of the scale 28, the slide 14 is displaced until the two target images are seen in coincidence in the eye-piece. Subsequently to the magnitude corresponding to this coincidence position having been read on the scale 26, the slide 14 is to be displaced to the left until the index 27 coincides with the zero line of the scale 26. The prism housing 21 is then displaced to the right, and the mount 23 containing the cuneiform prism 12 is rotated until the pin 24 touches the other stop 25. By further displacement of the prism housing 21 on the rule 22, the two target images visible in the field of view of the telescope 1 are made to coincide again, and the corresponding magnitude, indicated by the index 29, is read on the scale 28. The exact range, i. e., the range without errors, is obtained according to Equation 6, which reads in this case as follows:

$$(7) \qquad e=\frac{b_1-(-b_2)}{\delta.2}=\frac{b_1+b_2}{\delta.2}$$

b_1 and b_2 being the two base lengths determined. As the change in the positions of the prisms 10 and 15 in the two measurements entails reverse directions of the determined base lengths, the second base length is to be substituted negatively for $k=-1$, the difference of the bases being, accordingly, the sum of the absolute lengths. The lines of the scales 26 and 28 are naturally so spaced as a rule that the determination of the range can be effected simply by adding the two read magnitudes.

I claim:

1. A rangefinder comprising a housing, a telescope system containing an objective and an eyepiece being disposed in said housing, a reflecting system for deflecting the rays of two imaging ray pencils at 90° into said telescope system, said reflecting system consisting of two reflecting members displaceable relatively to each other, each of the ray entrance apertures of said members corresponding to one half of the ray entrance aperture of said telescope system, at least one slide, said slide being displaceable relatively to said housing, one of said reflecting members being mounted on said slide, means indicative of the distance apart of said members, and a cuneiform deviating prism for deviating the imaging rays at a definite angle, said deviating prism being in front of the ray entrance aperture of one of said reflecting members, and the ray entrance aperture of said deviating prism corresponding to the entire ray entrance aperture of said telescope system.

2. In a rangefinder according to claim 1, one of said reflecting members being rigidly connected to said housing, said cuneiform deviating prism being connected to last said reflecting member, a rule fixed to said housing, said slide being displaceably mounted on said rule, and said means indicative of the distances apart of said reflecting members being a scale on said rule and an index on said slide.

3. In a rangefinder according to claim 1, a reflecting system for deviating the imaging ray pencil of said telescope system at right angles, a bi-prism for doubling the exit pupil of said telescope system, the last said reflecting system and said bi-prism being disposed in said housing, the ridge of said bi-prism being parallel to the direction of relative displacement of said reflecting members and lying in the image plane of said telescope system, and a diaphragm, the aperture of said diaphragm being approximately in the plane of the exit pupil of said telescope system and corresponding to that portion of this plane in which parts of the doubled exit pupil overlap each other.

4. A rangefinder comprising a housing, a telescope system containing an objective and an eyepiece being disposed in said housing, a reflecting system for deflecting the rays of two imaging ray pencils at 90° into said telescope system, said reflecting system consisting of two reflecting members displaceable relatively to each other, each of the ray entrance apertures of said members corresponding to one half of the ray entrance aperture of said telescope system, two slides, two rules parallel to each other and disposed on said housing, one of said slides being displaceably mounted on the one of said rules, said other slide being displaceably mounted on the other of said rules, each of said reflecting member being fixed to one of said slides, means indicative of the distance apart of said reflecting members consisting of a scale representing ranges disposed on each of said rules and an index disposed on each of said slides, a cuneiform deviating prism for deviating the imaging rays at a definite angle, said cuneiform prism being rotatably mounted in front of the ray entrance aperture of one of said reflecting members on one of said slides, the ray entrance aperture of said cuneiform deviating prism corresponding to the entire ray entrance aperture of said telescope system, and means for restricting the rotation of said cuneiform prism to 180°.

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